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PRELIMINARY TESTS OF SYNTHETIC ORGANIC COMPOUNDS AS INSECTICIDES. PART II

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The results of laboratory tests of 883 synthetic organic compounds as insecticides, at the Sanford, Fla., laboratory, were reported in Part I of this series (3). A similar series of papers reporting other tests at this laboratory with other synthetic organic compounds has been published elsewhere (2). In the present paper 96 additional synthetic organic compounds are reported. Except as indicated otherwise, the methods of testing were the same as those described in Part I.

Most of the compounds reviewed in this paper were received and tested between October 1939 and December 1940. All the samples were received from the Division of Insecticide Investigations 2/, which either prepared or purchased the materials from commercial sources.

1/ M. C. Swingle resigned Dec. 18, 1943; J. B. Gahan was transferred to the Division of Insects Affecting Man and Animals Feb. 1, 1943; and A. M. Phillips was transferred to the Division of Fruit Insect Investigations July 1, 1941.

2/ The writers wish to acknowledge the assistance of R. C. Roark, H. L. Haller, and other members of the Division of Insecticide Investigations who supplied the compounds, as well as helpful data, including the formulas given in this paper.

For testing the compounds reported in this paper, 15 species were used as the test insects. The following insects were used:

American cockroach (*Periplaneta americana* (L.))
Cabbage looper (*Autographa brassicae* (Riley))
Cabbage webworm (*Hellula undalis* (F.))
Colorado potato beetle (*Leptinotarsa decemlineata* (Say))
Cross-striped cabbage worm (*Evergestis rimosalis* (Guen.))
Diamondback moth (*Plutella maculipennis* (Curt.))
Greenhouse leaf tier (*Phlyctaenia rubigalis* (Guen.))
Hawaiian beet webworm (*Hymenia fascialis* (Cram.))
Imported cabbage worm (*Pieris rapae* (L.))
Melon worm (*Diaphania hyalinata* (L.))
Rice weevil (*Sitophilus oryza* (L.))
Southern armyworm (*Prodenia eridania* (Cram.))
Southern beet webworm (*Pachyzancla bipunctalis* (F.))
Termites (*Reticulitermes* sp.)
Yellow woolly bear (*Diacrisia virginica* (F.))

All the species except the termites were reared in the laboratory, in order to standardize the population as much as possible and to insure their availability when desired. In some tests with cockroaches a paper disk heavily dusted with the insecticide was placed on the bottom of the jar.

Table 2 lists the results of tests on 30 organic compounds which were found to be toxic to one or more species of insects. Comparative tests on four commercial insecticides are reported in table 1. Eight of the compounds in table 2 are worthy of special mention. Three of these -- p-chloroacetophenone semicarbazone, p-chlorobenzene sulfonamide, and 2, 4-dimethyl-3-pentanone semicarbazone -- were effective against all the leaf-feeding insects on which they were tested. None of these compounds caused high mortality of all the insects, but survival was usually dependent upon very limited feeding.

The other five materials -- cyclohexanone semicarbazone, cyclopentanone semicarbazone, ethyl methyl ketone semicarbazone, 2-furaldehyde semicarbazone, and 2-nitroresorcinol -- were ineffective on at least one species, but effective against at least 60 percent of those tested. The most effective compound was 2-nitroresorcinol, which controlled five species out of the six leaf-feeding insects on which it was tested. Cyclohexanone semicarbazone was toxic to three of the four leaf-feeding species on which it was tested.

Of the 8 compounds mentioned, 6 were semicarbazones. These are all related chemically to acetone semicarbazone, which was reported as toxic in Part I. The semicarbazones are also closely related to 1, 4-diphenylsemicarbazide, which was found to be very toxic to insects (*1, 3*). Of 24 other semicarbazones listed in the table, only 10 gave any evidence of toxicity, and this was generally a repellent action with regard to feeding.

Another semicarbazide, 1-phenylsemicarbazide, listed in table 2, shows a tendency towards toxicity, but is not so effective as 1, 4-diphenylsemicarbazide, which has two phenyl groups rather than one.

Sixty-six other compounds tested during this period were found to be nontoxic, or only slightly toxic, and these are listed in alphabetical order in table 3. The insects against which they were tested are given in the table, but details of the tests are omitted because the results were almost entirely negative.

SUMMARY

This paper represents a continuation of tests reported in Part I under the same title. The results of preliminary laboratory tests to determine the toxicity to insects of 96 additional synthetic organic compounds are reported.

Eight compounds were found to be worthy of further work. Arranged in alphabetical order, the eight toxic compounds were p-chloroacetophenone semicarbazone, p-chlorobenzene sulfonamide, cyclohexanone semicarbazone, cyclopentanone semicarbazone, 2, 4-dimethyl-3-pentanone semicarbazone, ethyl methyl ketone semicarbazone, 2-furaldehyde semicarbazone, and 2-nitroresorcinol. These were effective on all, or nearly all, of the leaf-feeding insects against which they were tested. Six of the eight compounds were semicarbazones and therefore closely related chemically. A number of other semicarbazones tested were found to be less effective.

LITERATURE CITED

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(2) Swingle, M. C., Gahan, J. B., and Mayer, E. L.
1944. Laboratory tests of synthetic organic compounds as insecticides. Jour. Econ. Ent. 37: 70-74; 672-677; (in process).

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Table 1.--Results of laboratory toxicity tests of four standard insecticide materials against certain species of insects

Compound and Insect	Stage[1]	Foliage	Feeding[2]	Deposit	Kill in 48 hours[3]
				Micrograms per sq. cm.	Percent
Cryolite, synthetic					
American cockroach	Full grown	---	--	250	0
Cabbage looper	Fifth	Collards	1	345	84
Colorado potato beetle	Fourth	Potato	1	110	100
Cross-striped cabbage worm	First	Collards	0	250	100
	Fourth	do.	1	260	87
Diamondback moth	Second	do.	1	250	90
	Fourth	do.	1	250	70
Greenhouse leaf tier	Fifth	do.	1	95	93
Hawaiian beet webworm	Fourth	Beet	1	125	97
Melon worm	Fifth	Pumpkin	1	310	100
Southern armyworm	First	Collards	0	170	100
	Sixth	do.	1	170	97
Southern beet webworm	Fourth	Beet	1	155	97
Derris root, powdered, 4.5% rotenone					
American cockroach	Full grown	---	--	340	20
Cabbage looper	Fifth	Collards	1	140	67
Cabbage webworm	Third	do.	0	170	56
Colorado potato beetle	Fourth	Potato	1	125	100
Cross-striped cabbage worm	Fourth	Collards	1	185	53
Greenhouse leaf tier	Fifth	do.	2	250	0
Hawaiian beet webworm	Fourth	Beet	0	270	71
Imported cabbage worm	Second	Collards	0	75	100
	Fourth	do.	0	50	100
Melon worm	Fifth	Squash	1	230	60
Rice weevil	Adult	(Treated wheat)		[4]1:200	3
Southern armyworm	First	Collards	1	110	26
	Third	do.	3	110	0
	Fifth	do.	2	300	2
Termites	Adult	(Treated soil)		1:200	80
	do.	do.		1:1000	0

[1] Numbers refer to instar.

[2] 0= no visible feeding. 1 = trace, 2 = moderate, 3 = normal feeding. comparable with that on untreated foliage.

[3] Numbers in parentheses indicate number of hours if not 48.

[4] All proportions by weight.

Table 1.--(Continued)

Compound and Insect	Stage[1]	Foliage	Feeding[2]	Deposit	Kill in 48 hours[3]
				Micrograms per sq. cm.	Percent
Lead arsenate					
Cabbage looper	Fifth	Collards	2	95	50
Colorado potato beetle	Fourth	Potato	1	60	97
Cross-striped cabbage worm	First	Collards	0	70	100
	Fourth	do.	1	70	66
Diamondback moth	Second	do.	0	60	100
	Fourth	do.	0	60	87
Greenhouse leaf tier	Fifth	do.	1	140	100
Hawaiian beet webworm	Fourth	Beet	1	125	51
Melon worm	Fifth	Pumpkin	1	130	97
Southern armyworm	First	Collards	0	70	100
	Fourth	do.	1	70	22
Southern beet webworm	Fourth	Beet	1	110	53
Pyrethrum: 0.33% pyrethrin I 0.38% pyrethrin II					
American cockroach	Full grown	-	-	310	60
Cabbage looper	Fifth	Collards	1	140	97
Cross-striped cabbage worm	Fourth	do.	0	230	100
Greenhouse leaf tier	First	do.	0	230	100
	Fifth	do.	1	295	83
Hawaiian beet webworm	Fourth	Beet	0	230	100
Imported cabbage worm	Fifth	Collards	2	170	72
Melon worm	Fifth	Pumpkin	1	155	66
Rice weevil	Adult	(Treated wheat)		1:200	12
Southern armyworm	First	Collards	1	240	73
	Fourth	do.	2	240	10
	Sixth	do.	3	370	0
Southern beet webworm	Fourth	Beet	0	215	94
Termites	Adult	(Treated soil)		1:200	100
	do.	do.		1:1000	20

Table 2.—Results of laboratory toxicity tests of materials that were found to be toxic to certain species of insects

Compound	Insect	Stage[1]	Foliage	Feeding[2]	Deposit	Kill after 48 hours[3]
					Micrograms per sq. cm.	Percent
Acenaphthene $C_{10}H_6(CH_2)_2$	Colorado potato beetle	Fourth	Egg plant	0	155	100
		Fourth	do.	1	Fumigation	100
	Cross-striped cabbage worm	do.	Collards	3	110	0
	Melon worm	Fifth	Squash	2	215	0
	Southern armyworm	Sixth	Collards	3	155	0
o-Bromoacetanilide $CH_3CONHC_6H_4Br$	American cockroach	3/4 grown	--	-	325	0
	Cabbage webworm	Fourth	Collards	2	350	12
	Colorado potato beetle	do.	Egg plant	1	280	100
	Cross-striped cabbage worm	Second	Collards	1	255	100
		Fourth	do.	3	325	33
	Diamondback moth	Third	do.	1	350	63
	Greenhouse leaf tier	Fourth	do.	2	350	63
	Hawaiian beet webworm	Fifth	Beet	2	280	96
	Melon worm	Fourth	Squash	2	330	65
	Rice weevil	Adult	(Treated wheat)		[4]1:1000	0
	Southern armyworm	Twice	Collards	1	225	100
		Fifth	do.	2	230	40
	Southern beet webworm	Fourth	Beet	3	350	8
	Termites	Adult	(Treated soil)		1:1000	100
		do.	do.		1:5000	0
p-Bromoacetanilide $CH_3CONHC_6H_4Br$	Cabbage looper	First	Collards	2	115	25
	Cross-striped cabbage worm	do.	do.	2	95	59
		Third	do.	2	115	13
	Southern armyworm	Second	do.	1	210	86
		Fourth	do.	2	250	67
		Fifth	do.	3	220	50

[1] Numbers refer to instar.

[2] 0 = no visible feeding, 1 = trace, 2 = moderate, 3 = normal feeding, cimparable with that on untreated foliage.

[3] Numbers in parentheses indicate number of hours if not 48.

[4] All proportions by weight.

Table 2.—(Continued)

Compound	Insect	Stage[1]	Foliage	Feeding[2]	Deposit	Kill after 48 hours[3]
					Micrograms per sq. cm.	Percent
3-Chloroacenaphthene $C_{10}H_5(CH_2)_2Cl$	Cabbage looper	Fourth	Collards	3	260	0
	Cabbage webworm	Third	do.	1	400	60
	Colorado potato beetle	Fourth	Egg plant	1	145	35
	Cross-striped cabbage worm	do.	Collards	1	345	93
	Diamondback moth	do.	do.	1	400	0
	Greenhouse leaf tier	Fifth	do.	3	400	0
	Hawaiian beet webworm	do.	Beet	2	400	8
	Melon worm	do.	Pumpkin	2	115	13
	Rice weevil	Adult	(Treated wheat)		1:1000	11
	Southern armyworm	Sixth	Collards	3	345	0
	Southern beet webworm	Fourth	Beet	2	260	13
		Fifth	do.	2	400	0
	Termites	Adult	(Treated soil)		1:1000	70
					1:5000	10
o-Chloroactanilide $CH_3CONHC_6H_4Cl$	American cockroach	1/4 grown	—	-	590	0
	Cabbage looper	Fourth	Collards	3	200	0
	Cabbage webworm	do.	do.	2	230	24
	Colorado potato beetle	do.	Egg plant	0	230	95
	Cross-striped cabbage worm	do.	Collards	2	310	100
	Diamondback moth	Third	do.	0	230	100
	Greenhouse leaf tier	Fourth	do.	3	230	40
	Hawaiian beet webworm	Fifth	Beet	2	230	74
	Melon worm	Fourth	Squash	2	190	90
	Rice weevil	Adult	(Treated wheat)		1:1000	3
	Southern armyworm	Second	Collards	0	195	100
		Fourth	do.	1	270	90
		Fifth	do.	2	205	90
	Southern beet webworm	Fourth	Beet	1	230	96
	Termites	Adult	(Treated soil)		1:1000	100
		do.	do.		1:5000	26
	Yellow woolly bear	Fourth	Collards	0	465	100

Table 2.--(Continued)

Compound	Insect	Stage1/	Foliage	Feeding2/	Deposit	Kill after 48 hours 3/
					Micrograms per sq.cm.	Percent
p-Chloroacetanilide	American cockroach	1/4 grown	--	-	650	0
$CH_3CONHC_6H_4Cl$	Cabbage looper	First	Collards	2	145	33
	Cross-striped cabbage worm	First	do.	1	140	84
		Second	do.	2	240	8
	Diamondback moth	Fourth	do.	1	310	90
	Greenhouse leaf tier	Fifth	do.	2	370	0
	Hawaiian beet webworm	Fifth	Beet	3	310	0
	Melon worm	Fourth	Squash	2	465	9
	Southern armyworm	Second	Collards	2	209	37
	Southern beet webworm	Fifth	Beet	2	310	20
p-Chloroacetophenone semi-	American cockroach	3/4 grown	--	-	1/4 gm.	0
carbazone	Hawaiian beet webworm	Fifth	Swiss chard	1	385	89
$ClC_6H_4C(CH_3):NNHCONH_2$	Melon worm	Fourth	Pumpkin	1	287	26
	Southern armyworm	Fourth	Collards	1	385	33
	Southern beet webworm	Fifth	Swiss chard	1	495	73
p-Chlorobenzene sulfonamide	American cockroach	3/4 grown	--	-	405	30
$ClC_6H_4SO_2NH_2$	Hawaiian beet webworm	Fifth	Swiss chard	1	384	80
	Rice weevil	Adult	(Treated wheat)		1:1000	0
	Southern armyworm	Fourth	Collards	1	575	73
	Southern beet webworm	Fifth	Swiss chard	1	420	97
	Yellow woolly bear	Fourth	Collards	1	465	48
Copper phenylstearoarsenite	Colorado potato beetle	Fourth	Egg plant	1	110	100
	Cross-striped cabbage worm	Fourth	Collards	1	110	100
	Melon worm	Fifth	Squash	1	165	90
	Southern armyworm	Fourth	Collards	1	84	100
		Sixth	do.	1	145	97

Table 2.—(Continued)

Compound	Insect	Stage[1]	Foliage	Feeding[2]	Deposit	Kill after 48 hours [3]
					Micrograms per sq. cm.	Percent
Cyclohexanone semicarbazone	American cockroach	3/4 grown	—	-	1/4 gm.	0
$C_6H_{10}:NNHCONH_2$	Cross-striped cabbage worm	Fifth	Collards	2	310	100
	Hawaiian beet webworm	do.	Swiss chard	1	240	100
		do.	do.	3	Fumigation	12
	Southern armyworm	Fourth	Collards	3	240	0
	Southern beet webworm	Fifth	Swiss chard	1	130	100
Cyclopentanone semicarbazone	American cockroach	3/4 grown	—	-	1/4 gm.	0
$C_5H_8:NNHCONH_2$	Hawaiian beet webworm	Fifth	Swiss chard	1	325	96
	Imported cabbage worm	do.	Collards	2	325	32
	Melon worm	Fourth	Pumpkin	1	325	24
	Southern armyworm	do.	Collards	2	345	7
	Southern beet webworm	Fifth	Swiss chard	1	250	100
	Termites	Adult	(Treated soil)		1:5000	0
2,6-Dimethyl-4-heptanone	Hawaiian beet webworm	Fifth	Swiss chard	1	185	64
semicarbazone	Imported cabbage worm	do.	Collards	2	185	72
$[(CH_3)_2CHCH_2]_2C:NNHCONH_2$	Melon worm	Fourth	Pumpkin	2	185	4
	Southern armyworm	do.	Collards	3	185	0
	Southern beet webworm	Fifth	Swiss chard	2	175	53
	Termites	Adult	(Treated soil)		1:1000	0
		do.	do.		1:5000	(72) 5
2,4-Dimethyl-3-pentanone	American cockroach	3/4 grown	—	-	1/4 grown	0
semicarbazone	Hawaiian beet webworm	Fifth	Swiss chard	1	280	76
$[(CH_3)_2CH]_2C:NNHCONH_2$	Melon worm	Fourth	Pumpkin	1	230	48
	Southern armyworm	do.	Collards	1	280	97

Table 2.—(Continued)

Compound	Insect	Stage[1]	Foliage	Feeding[2]	Deposit	Kill after 48 hours[3]
					Micrograms per.sq.cm.	Percent
Diphenyl ester of carbonic acid $(C_6H_5O)_2CO$	American cockroach	3/4 grown	—	-	370	0
	Colorado potato beetle	Fourth	Egg plant	1	175	90
	Cross-striped cabbage worm	do.	Collards	1	145	100
	Diamondback moth	do.	do.	1	230	97
	Greenhouse leaf tier	do.	do.	3	385	17
	Hawaiian beet webworm	Fifth	Beet	3	230	0
	Melon worm	Fourth	Squash	1	295	46
	Rice weevil	Adult	(Treated wheat)		1:1000	0
	Southern armyworm	Sixth	Collards	3	140	3
	Southern beet webworm	Fifth	Beet	3	230	0
	Termites	Adult	(Treated soil)		1:1000	(72)93
					1:5000	(72) 7
Ethyl methyl ketone semicarbazone $C_2H_5C(:NNHCONH_2)CH_3$	American cockroach	3/4 grown	—	-	1/4 gm.	0
	Hawaiian beet webworm	Fifth	Swiss chard	1	385	96
	Imported cabbage worm	do.	Collards	2	385	16
	Melon worm	Fourth	Pumpkin	1	385	24
	Southern armyworm	do.	Collards	3	533	0
	Southern beet webworm	Fifth	Swiss chard	1	680	100
	Termites	Adult	(Treated soil)		1:1000	(72) 9
					1:5000	(72) 3
2-Furaldehyde semicarbazone $(C_4H_3O)CH:NNHCONH_2$	Hawaiian beet webworm	Fifth	Swiss chard	1	385	88
	Imported cabbage worm	do.	Collards	2	385	96
	Melon worm	Fourth	Pumpkin	1	435	72
	Southern armyworm	do.	Collards	1	510	0
	Southern beet webworm	Fifth	Swiss chard	2	230	53

Table 2.—(Continued)

Compound	Insect	Stage[1/]	Foliage	Feeding [2/]	Deposit	Kill after 48 hours [3/]
					Micrograms per sq.cm.	Percent
2-Furan acrylamide $(C_4H_3O)CH:CHCONH_2$	Hawaiian beet webworm	Fifth	Swiss chard	2	155	12
	Imported cabbage worm	Fifth	Collards	3	155	80
	Melon worm	Fourth	Pumpkin	1	280	96
	Southern armyworm	Fourth	Collards	1	385	57
	Southern beet webworm	Fifth	Swiss chard	2	325	40
1-Hydroxy-2-acetonaphthone $C_{10}H_6(OH)COCH_3$	Greenhouse leaf tier	Fourth	Collards	2	200	67
	Hawaiian beet webworm	Fifth	Beet	3	310	0
	Melon worm	Fourth	Squash	3	310	4
	Rice weevil	Adult	(Treated wheat)		1:1000	0
	Southern armyworm	Third	Collards	0	200	100
	Southern beet webworm	Fourth	Beet	2	200	20
	Termites	Adult	(Treated soil)		1:1000 1:5000	(72) 22 (72) 6
	Yellow woolly bear	Fourth	Collards	3	265	4
o-Iodoacetanilide $CH_3CONHC_6H_4I$	American cockroach	3/4 grown	---	--	360	0
	Cabbage webworm	Fourth	Collards	3	280	4
	Colorado potato beetle	Fourth	Potato	1	290	100
	Cross-striped cabbage worm	Fourth	Collards	3	280	38
	Diamondback moth	Third	do.	2	280	0
	Greenhouse leaf tier	Fourth	do.	3	280	0
	Hawaiian beet webworm	Fifth	Swiss chard	3	310	58
	Melon worm	Fourth	Squash	2	425	75
	Rice weevil	Adult	(Treated wheat)		1:1000	0
	Southern armyworm		Collards	3	202	39
	Southern beet webworm	Fourth	Beet	3	280	0
	Termites	Adult	(Treated soil)		1:1000 1:5000	100 0

Table 2.—(Continued)

Compound	Insect	Stage[1]	Foliage	Feeding[2]	Deposit	Kill after 48 hours[3]
					Micrograms per sq. cm.	Percent
2-Naphthyl methyl ether $C_{10}H_7OCH_3$	American cockroach	3/4 grown	---	--	1/4 gm.	20
	Colorado potato beetle	Fourth	Egg plant	0	170	100
	Cross-striped cabbage worm	First	Collards	1	150	80
		Third	do.	0	200	97
		Fifth	do.	0	200	100
	Diamondback moth	Fourth	do.	1	250	93
	Greenhouse leaf tier	Fifth	do.	3	340	0
	Hawaiian beet webworm	Fifth	Beet	2	250	12
	Imported cabbage worm	First	Collards	0	150	100
	Melon worm	Fifth	Squash	2	115	26
	Southern armyworm	First	Collards	0	150	100
		Third	do.	0	200	94
		Fourth	do.	0	435	100
	Southern beet webworm	Fifth	Beet	2	250	20
p-Nitroacetanilide $CH_3CONHC_6H_4NO_2$	American cockroach	3/4 grown	---	-	1/4 gm.	0
	Hawaiian beet webworm	Fifth	Swiss chard	1	155	75
	Melon worm	Fourth	Squash	2	405	30
	Southern armyworm	Fourth	Collards	2	200	0
	Southern beet webworm	Fourth	Swiss chard	2	405	80
	Yellow woolly bear	Fourth	Collards	2	230	60
2-Nitroresorcinol $(NO_2)C_6H_3(OH)_2$	American cockroach	3/4 grown	---	--	1335	40
	Greenhouse leaf tier	Fourth	Collards	2	185	97
	Hawaiian beet webworm	Fifth	Beet	0	340	100
	Melon worm	Fourth	Squash	3	340	4
	Rice weevil	Adult	(Treated wheat)		1:1000	22
		do.	do.		1:5000	20
	Southern armyworm	Third	Collards	0	185	100
	Southern beet webworm	Fourth	Beet	0	185	88
	Termites	Adult	(Treated soil)		1:1000	100
		do.	do.		1:5000	0
	Yellow woolly bear	Fourth	Collards	0	620	100

Table 2.—(Continued)

Compound	Insect	Stage[1]	Foliage	Feeding[2]	Deposit	Kill after 48 hours[3]
					Micrograms per sq. cm.	Percent
Phenazine oxide $C_6H_4NC_6H_4NO$	Hawaiian beet webworm	Fifth	Swiss chard	1	130	92
	Melon worm	Fourth	Pumpkin	2	192	14
	Southern armyworm	Fourth	Collards	3	130	0
	Southern beet webworm	Fifth	Swiss chard	2	155	73
	Yellow woolly bear	Fourth	Collards	2	170	56
beta-Phenylhydrazide of phenylazoformic acid $C_6H_5N{:}NCONHNHC_6H_5$	Greenhouse leaf tier	Fourth	Collards	1	185	63
	Hawaiian beet webworm	Fifth	Beet	2	185	7
	Melon worm	Fourth	Squash	2	185	13
	Rice weevil	Adult	(Treated wheat)		1:1000	4
	Southern armyworm	Third	Collards	2	185	13
	Southern beet webworm	Fourth	Beet	2	185	24
	Termites	Adult	(Treated soil)		1:1000	(72)10
		do.	do.		1:5000	(72) 0
	Yellow woolly bear	Fourth	Collards	3	310	12
1-Phenylsemicarbazide $C_6H_5NHNHCONH_2$	Greenhouse leaf tier	Fourth	Collards	1	200	53
	Hawaiian beet webworm	Fifth	Beet	2	230	7
	Melon worm	Fourth	Squash	2	230	45
	Southern armyworm	Third	Collards	2	200	33
	Southern beet webworm	Fourth	Beet	2	200	84
	Yellow woolly bear	Fourth	Collards	3	410	12
Rhodanine $OCCH_2SC({:}S)NH$	Greenhouse leaf tier	Fourth	Collards	2	250	90
	Hawaiian beet webworm	Fifth	Beet	2	355	41
	Melon worm	Fourth	Squash	2	355	10
	Rice weevil	Adult	(Treated wheat)		1:1000	0
	Southern armyworm	Third	Collards	1	250	87
	Southern beet webworm	Fourth	Beet	2	250	4
	Termites	Adult	(Treated soil)		1:1000	4
		do.	do.		1:5000	3
	Yellow woolly bear	Fourth	Collards	2	620	29

Table 2.—(Continued)

Compound	Insect	Stage[1]	Foliage	Feeding [2]	Deposit	Kill after 48 hours [3]
					Micrograms Per sq.cm.	Percent
Salicylaldehyde semicarbazone $HOC_6H_4CH{:}NNHCONH_2$	Hawaiian beet webworm	Fifth	Swiss chard	2	495	76
	Imported cabbage worm	Fifth	Collards	3	495	16
	Melon worm	Fourth	Pumpkin	2	230	12
	Southern armyworm	Fourth	Collards	3	580	0
	Southern beet webworm	Fifth	Swiss chard	1	565	80
	Termites	Adult	(Treated soil)		1:1000	(72) 0
		do.	do.		1:5000	(72) 3
Thio-2-naphthyl methyl ether $C_{10}H_7SCH_3$	Colorado potato beetle	Fourth	Egg plant	1	70	90
	Cross-striped cabbage worm	Fourth	Collards	3	35	0
	Melon worm	Fourth	Pumpkin	1	230	100
	Rice weevil	Adult	(Treated wheat)		1:1000	8
	Southern armyworm	Sixth	Collards	3	70	0
	Southern beet webworm	Fifth	Swiss chard	2	180	40
	Termites	Adult	(Treated soil)		1:1000	100
					1:5000	20
	Yellow woolly bear	Fourth	Collards	1	200	100
Tris(p-aminophenyl)carbinol $(NH_2C_6H_4)_3COH$	Greenhouse leaf tier	Fourth	Collards	1	230	100
	Hawaiian beet webworm	Fifth	Beet	2	310	19
	Melon worm	Fourth	Squash	2	310	35
	Rice weevil	Adult	(Treated wheat)		1:1000	0
	Southern armyworm	Third	Collards	2	230	30
	Southern beet webworm	Fourth	Beet	1	230	36
	Termites	Adult	(Treated soil)		1:1000	(72) 0
					1:5000	(72) 9
	Yellow woolly bear	Fourth	Collards	3	575	0

Table 2.- (Continued)

Compound	Insect	Stage[1]	Foliage	Feeding[2]	Deposit	Kill after 48 hours[3]
					Micrograms Per sq. cm.	Percent
Xanthone $C_6H_4COC_6H_4O$	Cross-striped cabbage worm	Fourth	Collards	2	200	16
	Diamondback moth	Fourth	do.	1	200	73
	Greenhouse leaf tier	Fifth	do.	1	200	40
	Hawaiian beet webworm	Fifth	Beet	1	200	52
	Melon worm	Third	Squash	2	200	4
		Fifth	Pumpkin	2	215	0
	Rice weevil	Adult	(Treated wheat)		1:1000	8
	Southern armyworm	First	Collards	0	150	98
		Third	do.	1	150	47
		Fifth	do.	3	150	0
	Southern beet webworm	Fifth	Beet	2	200	24
	Termites	Adult	(Treated soil)		1:1000	(72) 87
					1:5000	(72) 0

Table 3.--Experimental materials that were found to be ineffective against the insects on which they were tested

Compound	Insect	Stage[1]
3-Acenaphthenamine $C_{10}H_5(CH_2)_2NH_2$	Cross-striped cabbage worm	Fifth
	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	First
	Southern beet webworm	Fifth
	Yellow woolly bear	Fourth
N-(3-Acenaphthenyl)-acetamide $CH_3CONHC_{10}H_5(CH_2)_2$	Cross-striped cabbage worm	Fifth
	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	First
	Southern beet webworm	Fifth
	Yellow woolly bear	Fourth
Acenaphthenylphenyl ketone $C_6H_5COC_{10}H_5(CH_2)_2$	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern beet webworm	Fourth
Acetoacetic acid ethyl ester semicarbazone $CH_3C(:NNHCONH_2)CH_2COOC_2H_5$	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
Acetonyl acetone disemicarbazone $(CH_3C(:NNHCONH_2)CH_2)_2$	Hawaiian beet webworm	Fifth
	Imported cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
	Termites	Adult
Acetophenone semicarbazone $C_6H_5C(:NNHCONH_2)CH_3$	Hawaiian beet webworm	Fifth
	Imported cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
	Termites	Adult
3-Acetyl-6-methyl-1,2-pyran-2,4-(3)-dione(dehydroacetic acid) $OCCH:C(CH_3)OC(O)CHCOCH_3$	Hawaiian beet webworm	Fifth
	Imported cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
	Termites	Adult

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[1] Numbers refer to instar.

Table 3.—(Continued)

Compound	Insect	Stage[1]
p-Aminobenzophenone semicarbazone $NH_2C_6H_4C(C_6H_5):NNHCONH_2$	Cross-striped cabbage worm	Fifth
	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
Anisalacetophenone $CH_3OC_6H_4CH:CHCOC_6H_5$	American cockroach	3/4 grown
	Melon worm	Fourth
	Southern armyworm	Fifth
	Southern beet webworm	Fifth
Arsenic salt of dithiocarbamic acid of morpholine $[O(CH_2CH_2)_2NC:SS]_3As$	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
Benzaldehyde semicarbazone $C_6H_5CH:NNHCONH_2$	Hawaiian beet webworm	Fifth
	Imported cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
	Termites	Adult
Benzal diacetophenone $C_6H_5CH(CH_2COC_6H_5)_2$	American cockroach	3/4 grown
	Melon worm	Fourth
	Southern armyworm	Fifth
	Southern beet webworm	Fifth
N-Benzal-S-(o-nitrophenyl)-sulfuramine $NO_2C_6H_4SN:CHC_6H_5$	Cross-striped cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
Benzil monosemicarbazone $C_6H_5COC(C_6H_5):NNHCONH_2$	Cross-striped cabbage worm	Fifth
	Hawaiian beet webworm	Fifth
	Southern armyworm	Fourth
Benzoin semicarbazone $C_6H_5CH(CH)C(:NNHCONH_2)C_6H_5$	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
	Termites	Adult
Benzophenone semicarbazone $(C_6H_5)_2C:NNHCONH_2$	Hawaiian beet webworm	Fifth
	Imported cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
	Yellow woolly bear	Fourth

Table 3.—(Continued)

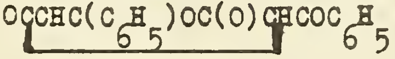
Compound	Insect	Stage[1]
Benzoyl perioxide $(C_6H_5CO)_2O_2$	Cross-striped cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
3-Benzoyl-6-phenyl-1,2-pyran-2,4(3)-dione  $\underbrace{OCCHC(C_6H_5)OC(O)C}HCOC_6H_5$	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
3-Bromoacenaphthene $C_{10}H_5(CH_2)_2Br$	Colorado potato beetle	Fourth
m-Bromoacetanilide $CH_3CONHC_6H_4Br$	Cross-striped cabbage worm	Second
	Southern armyworm	Second
N-Carvacrylpalmitamide $C_{15}H_{31}CONHC_6H_3(CH_3)$ (C_3H_7)	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fourth
	Yellow woolly bear	Fourth
N-Carvacrylpropionamide $C_2H_5CONHC_6H_3(CH_3)(C_3H_7)$	Hawaiian beet webworm	Fifth
	Imported cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
	Termites	Adult
m-Chloroacetanilide $CH_3CONHC_6H_4Cl$	Cross-striped cabbage worm	Second
	Southern armyworm	Second
o-Chlorobenzaldehyde semicarbazone $ClC_6H_4CH:NNHCONH_2$	American cockroach	3/4 grown
	Cross-striped cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fifth
	Southern beet webworm	Fifth
Cinnamaldehyde semicarbazone $C_6H_5CH:CHCH:NNHCONH_2$	Hawaiian beet webworm	Fifth
	Imported cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
	Termites	Adult

Table 3.--(Continued)

Compound	Insect	Stage[1]
Copper salt of dithiocarbamic acid of morpholine $[O(CH_2CH_2)_2NC:SS]_2Cu$	Hawaiian beet webworm	Fifth
	Imported cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
Crotonaldehyde semicarbazone $CH_3CH:CHCH:NNHCONH_2$	Hawaiian beet webworm	Fifth
	Imported cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
	Termites	Adult
alpha-Cyanoacetanilide $CNCH_2CONHC_6H_5$	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
Dibenzaltriacetophenone (isomer B) $[C_6H_5COCH_2CH(C_6H_5)]_2CHCOC_2H_5$	American cockroach	3/4 grown
	Melon worm	Fourth
	Southern armyworm	Fifth
	Southern beet webworm	
3,4-Dichloroacetophenone semicarbazone $Cl_2C_6H_3C(CH_3):NNHCONH_2$	Cross-striped cabbage worm	Fifth
	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
Dimethylglyoxime $(CH_3C:NOH)_2$	Cross-striped cabbage worm	First
		Third
	Southern armyworm	First
		Third
3,7-Dimethylthianthrene $\underbrace{CH_3C_6H_3SC_6H_3(CH_3)S}$	Cross-striped cabbage worm	Fifth
	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
Dinitroacenaphthene $C_{10}H_4(CH_2)_2(NO_2)_2$	Colorado potato beetle	Fourth
	Cross-striped cabbage worm	Fourth
	Melon worm	Fifth
	Southern armyworm	Sixth
alpha,delta-Diphenylcarbohydrazide $(C_6H_5NHNH)_2CO$	Colorado potato beetle	Fourth
	Diamondback moth	Fourth
	Greenhouse leaf tier	Fourth
	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Third
	Southern beet webworm	Fourth
	Yellow woolly bear	Sixth

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Table 3.--(Continued)

Compound	Insect	Stage[1]
alpha-Ethylbutyraldehyde semicarbazone $(C_2H_5)_2CHCH{:}NNHCONH_2$	Hawaiian beet webworm	Fifth
	Imported cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
	Termites	Adult
2-Fluoryl phenyl ketone $C_{13}H_9COC_6H_5$	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern beet webworm	Fourth
N-Fural-S-(o-nitrophenyl)-sulfuramine $NO_2C_6H_4SNC(C_4H_3O)$	Cross-striped cabbage worm	Fifth
	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
2-(d-Gluco-d-gulohepto-hexahydroxyhexyl) benzimidazole $CH_2OH(CHOH)_5C{:}NC_6H_4NH$	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
2-Heptanone semicarbazone $CH_3(CH_2)_4C(CH_3){:}NNHCONH_2$	Cross-striped cabbage worm	Fifth
	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
p-Hydroxyacetophenone semicarbazone $HOC_6H_4C({:}NNHCONH_2)CH_3$	Hawaiian beet webworm	Fifth
	Imported cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
	Termites	Adult
2-Hydroxybenzaldiacetophenone $HOC_6H_4CH(CH_2COC_6H_5)_2$	American cockroach	3/4 grown
	Melon worm	Fourth
	Southern armyworm	Fifth
	Southern beet webworm	Fifth
m-Iodoacetanilide $CH_3CONHC_6H_4I$	Colorado potato beetle	Fourth
	Cross-striped cabbage worm	Second
	Southern armyworm	Second
p-Iodoacetanilide $CH_3CONHC_6H_4I$	Colorado potato beetle	Fourth
	Cross-striped cabbage worm	Second
	Southern armyworm	Second

Table 3.--(Continued)

Compound	Insect	Stage[1]
Iron salt of dithiocarbamic acid of morpholine $[O(CH_2CH_2)_2NCSS]_3Fe$	Hawaiian beet webworm	Fifth
	Imported cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
Levulinic acid semicarbazone $CH_3C(:NNHCONH_2)CH_2CH_2COOH$	American cockroach	3/4 grown
	Cross-striped cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fifth
	Southern beet webworm	Fifth
Mercury salt of dithiocarbamic acid of morpholine $[O(CH_2CH_2)_2NO:SS]_2Hg$	Hawaiian beet webworm	Fifth
	Imported cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
3-Methoxy-4-hydroxybenzal-p-aminobenzoic acid $CH_3OC_6H_3(OH)CH:NC_6H_4COOH$	American cockroach	3/4 grown
	Melon worm	Fourth
	Southern armyworm	Fifth
	Southern beet webworm	Fifth
p-Methylacetophenone semicarbazone $CH_3C_6H_4C(CH_3):NNHCONH_2$	Hawaiian beet webworm	Fifth
	Imported cabbage worm	Fifth
	Melon worm	Fourth
	Southern beet webworm	Fifth
	Termites	Adult
3,4-Methylenedioxybenzal-p-aminobenzoic acid $OCH_2OC_6H_3CH:NC_6H_4COOH$	American cockroach	3/4 grown
	Melon worm	Fourth
	Southern armyworm	Fifth
	Southern beet webworm	Fifth
4-Methyl-2-pentanone semicarbazone $(CH_3)_2CHCH_2C(CH_3):NNHCONH_2$	Hawaiian beet webworm	Fifth
	Imported cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
	Termites	Adult
Methyl propyl ketone semicarbazone $CH_3C(:NNHCONH_2)C_3H_7$	Hawaiian beet webworm	Fifth
	Imported cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
	Termites	Adult

Table 3.—(Continued)

Compound	Insect	Stage[1]
Morpholine salt of dithiocarbamic acid of morpholine $O(CH_2CH_2)_2NC(:S)SNH_2(CH_2CH_2)_2O$	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
3-Nitroacenaphthene $C_{10}H_5(CH_2)_2NO_2$	Colorado potato beetle	Fourth
	Cross-striped cabbage worm	Fourth
	Melon worm	Fifth
	Southern armyworm	Sixth
4-(o-Nitrophenylmercapto)-resorcinol $NO_2C_6H_4SC_6H_3(OH)_2$	Cross-striped cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
	Yellow woolly bear	Fourth
N-(o-Nitrophenylmercapto)-p-toluidine $NO_2C_6H_4SNHC_6H_4CH_3$	Cross-striped cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
S-(o-Nitrophenyl)-sulfuramine $NO_2C_6H_4SNH_2$	Cross-striped cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	First
	Southern beet webworm	Fifth
	Yellow woolly bear	Fourth
2- Octanone semicarbazone $CH_3(CH_2)_5C(CH_3):NNHCONH_2$	Hawaiian beet webworm	Fifth
	Imported cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
	Southern beet webworm	Fifth
	Termites	Adult
Piperidine-piperidyl dithiocarbamate $(C_5H_{10}N)C(:S)SH(C_5H_{11}N)$	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
Piperonal semicarbazone $OCH_2OC_6H_3CH:NNHCONH_2$	American cockroach	3/4 grown
	Cross-striped cabbage worm	Fifth
	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fifth
	Southern beet webworm	Fifth

Table 3.--(Continued)

Compound	Insect	Stage[1]
Sulfurized nicotine	Cross-striped cabbage worm	Fifth
	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
2,4,2',4'-Tetrabromodiphenylamine $Br_2C_6H_3NHC_6H_3Br_2$	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
2,4,2',4'-Tetrachlorodiphenylamine $Cl_2C_6H_3NHC_6H_3Cl_2$	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
Thianthrene $\left[C_6H_4SC_6H_4S\right]$	Cross-striped cabbage worm	Fifth
	Hawaiian beet webworm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
p-Tolyl lactamide $CH_3CHOHCONHC_6H_4CH_3$	Hawaiian beet webworm	Fifth
	Imported cabbage worm	Fifth
	Melon worm	Fourth
	Southern armyworm	Fourth
Vanillia semicarbazone $CH_3OC_6H_3(OH)CH{:}NNHCONH_2$	American cockroach	3/4 grown
	Melon worm	Fourth
	Southern armyworm	Fifth
	Southern beet webworm	Fifth
Zinc salt of dithiocarbamic acid of morpholine $(O(CH_2CH_2)_2NC{:}SS)_2Zn$	Cross-striped cabbage worm	Fourth
	Diamondback moth	Fourth
	Greenhouse leaf tier	Fifth
	Hawaiian beet webworm	Fifth
	Imported cabbage worm	Fifth
	Melon worm	Third
	Southern armyworm	Fourth
	Southern beet webworm	Fifth

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